LEVEL II

Research Memorandum 78-26

TRAINING IN THE DARK OF THE DAY

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TRAINING IN THE DARK OF THE DAY

"One of the fundamental difficulties of night training is the limitations it puts upon maneuver control and simple observation by the trainer for the purposes of post exercise critique. Moreover, night training is inherently inefficient, because of the difficulties of control impacting over logistic and administrative arrangements surrounding an exercise. One answer may be to conduct night training during the day, by equipping all participants with goggles which simulate the night visual environment." (1975)

MG Paul F. Gorman
Deputy Chief of Staff for Training
HQ TRADOC

INTRODUCTION

The officer-in-charge of the Night Fire Rifle Range at one of the major Army training centers, notices that the last round has just been fired. He glances at his wristwatch and much to his dismay sees that it is 0330 hrs. His experience tells him that at least another hour will be required to "break down" the range, store the equipment, collect and segregate the empty cartridges and ammunition, and police the area. By the time the troops reach their barracks and his own cadre return to their quarters, the sun will be rising. Although the Night Fire Range is equipped with the latest automated range equipment, no solution has been found to overcome the long, tedious hours when a double company of trainees has been scheduled to fire. The morale of everyone present at this time really sags with the realization that tomorrow is another training day.

Though hypothetical, the situation depicted above is a real-life problem for the Basic Training Committee Group at Fort Jackson, S.C. Due to holidays, pay days, and other scheduling anomalies, it often becomes necessary to have more than one training company fire on a given night. Thus, the Night Fire Rifle Range is required to remain in operation for an extended period of time, creating hardships for trainees and cadre alike. The optimal solution would be to develop a means of simulating night illumination conditions during daylight when the range normally is not used, so that night fire training can be conducted at this time. The purpose of this research memorandum is to introduce technological aids called Light Attenuation Devices (LADs) which provide such a solution. The concept of using LADs to produce features of night visibility for training purposes is being developed and evaluatd by ARI, the US Army Research Institute for the Behavioral and Social Sciences.

The simulation of night illumination levels for training, using LADs, could provide several benefits over actual night training in terms of safety, training effectiveness, and scheduling flexibility. Safety is increased through the use of LADs since performances of individuals, teams, or groups can be monitored by someone whose (daylight) vision is unimpaired. For example, during simulated night rifle marksmanship and record firing, the cadre, who are not wearing LADs, could more easily conduct routine inspections for possession of unexpended ammunition. Training effectiveness would be enhanced since the cadre could observe, evaluate, and correct trainees' performance. Thus performers would receive corrective feedback based on a more accurate and extensive observation of their behavior. Finally, using training with LADs as an adjunct to conducting night exercises and qualification tests could enhance the flexibility of scheduling. This increased flexibility would be especially advantageous to training centers with limited facilities. A related benefit is that more efficient scheduling would reduce the amount of "dead" time usually spent waiting for darkness.

PREVIOUS ATTEMPTS TO DEVELOP LADS

The concept of light attenuation for operational and training purposes is not a new one. The U. S. Armed Forces have used light-attenuating goggles in the past, both to protect the eyes and to improve human performance. Perhaps the best known use of goggles to improve performance was the introduction of red goggles in World War II. The goggles were used to promote dark adaptation for Army aviators and Navy personnel prior to either night flights or night watch duty. Another type of device was a dual density goggle with a dense strip near the top that was used by pilots in WW II to facilitate searching for enemy aircraft when flying in line with the sun.

Some past efforts also have been directed specifically toward the simulation of night illumination levels during daylight for the purposes of training and evaluation. However, since most of these attempts were relatively unsuccessful, this work has largely gone unpublished. In the context of the Infantryman, an attempt was made to conduct night training with dark goggles during the day, in tests at Fort Benning in 1959. The feasibility of the concept was investigated, but the project was cancelled before extensive training took place.

A more vigorous effort was made in 1969, in tests sponsored by the Training Aids section of Fifth Army Headquarters at Fort Sheridan. The preliminary studies used exposed X-ray film as a light-attenuating filter in the standard Army sun, wind, and dust goggle. Results of these early trials were encouraging, and a filter was sought that would be superior to exposed photographic film.

A plastic containing a dispersion of colloidal carbon was used to construct a lens with an optical density (OD) of about 5.5[1]. A total of 7,000 lenses was produced for extensive field trials which had some success. However, problems with perspiration fogging the lenses and light scatter when facing the sun led to the projects's termination in August 1970. Those involved in the effort believed that such technological problems could have been resolved if the project had possessed more resources and there had been continuity in command.

ROLE OF ARI IN THE DEVELOPMENT OF LADS

In 1974, ARI became seriously involved in developing the concept of training with LADs, under Aaron Hyman, Chief of the ARI Technical Area dealing with Human Factors in Tactical Operations. In order to achieve Army-wide acceptance for these devices, LADs were considered to require the following characteristics:

(a) a relatively neutral attenuation in the visible range
(b) attenuation of light in the ultraviolet and infrared regions for safety reasons
(c) a light-tight seal to the face
(d) adequate simulation of various illumination levels
(e) a fairly wide field of view
(f) durable lenses with abrasion-resistant coating
(g) an outer protective cover
(h) capable of accommodating a wearer who uses corrective lenses
(i) an adequate ventilating system

Following initial exploratory work by John P. Farrell, light-attenuating devices were developed at ARI by Hyman and Farrell, who used metallic-coated plastic filters in combination with Kodak Wratten neutral density (#96) filters[2] inserted in the standard Army sun, wind, and dust goggle, but with improved light-tight ventilation.

Farrell field tested these goggles for Infantry tasks at Fort Ord and aviation tasks at Fort Rucker. For the aviator tasks, a bidensity lens was used in which the lower part of the lens was less attenuating than the upper, thus allowing the pilot to read the instrument panel and flight instructions. The results of these preliminary field tests in

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[1] Optical density refers to amount of light allowed to filter through the lens. For example, a numerical value of 5.0 indicates that 10^{-5} or .001% of the light is allowed through the lens. For a clear sunny day, this corresponds approximately to the level of illumination produced by a full moon on a clear night.

[2] Commercial designations are used only in the interest of precision in reporting and do not constitute indorsement by the Army or ARI.

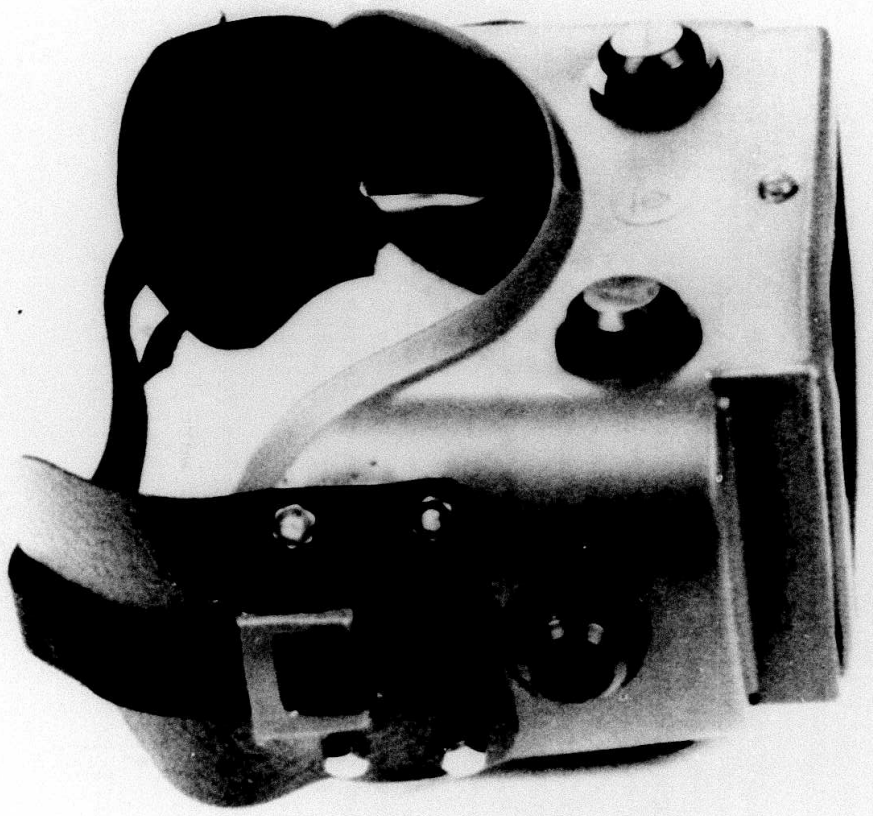

Figure 1. Welder's version of LADs (side view).

1975 were very encouraging since performances with the LADs appeared to be degraded to the same extent as performances under actual night visual conditions. Unfortunately, the initial mock-up version of these LADs was too fragile and expensive for field application.

In the next stage of development, ARI scientists utilized neutral attenuating lenses made of relatively durable and inexpensive dyed polycarbonate plastic with a metallic coating, which fit as outserts on the standard Army M17 protective mask. These LADs were used to simulate night illumination conditions for conducting ARI land navigation research with elements of the 9th Infantry division at Fort Lewis in early 1977.

In response to a field request from Fort Jackson, ARI developed a light-attenuating goggle that can accommodate those helmeted trainees who wear corrective lenses. The goggle lens is made of a combination of flat polycarbonate plastic filters containing an organic dye, with a metallic coating on one of the lenses to filter out potentially harmful infrared and ultraviolet rays. The compartment holding the filters can be disassembled easily or removed intact so that different filter combinations can be readily obtained or interchanged. The compartment also contained a clear, shatterproof outer lens to protect the filters. A commercial welder's goggle was used for the facemask, made of a soft, opaque green material and ventilated by plastic louvers. Added foam padding templeflaps reduced the amount of light leakage around the ears. The perimeter of the mask in contact with the cheekbone, forehead, and nose was also lined with foam to increase light-tightness (Figures 1 & 2).

NIGHT RIFLE MARKSMANSHIP FIELD TEST OF LADS

During the early part of 1978, the Basic Training Committee Group at Fort Jackson conducted a field test of the feasibility of using LADs for training and testing night rifle marksmanship during daylight. The stated objectives of the Fort Jackson test are given in Table 1. The field test employed an experimental design in which 15 training companies, composed of both sexes, were divided randomly into four groups. For three of the groups, the optical density of the goggles was varied to determine how their performance compared with that of the fourth group, which performed actual night fire at various moon phases (full, half, and no moon). Potential sources of extraneous variability were to be controlled by holding constant the prior rifle training and practice, instructions, and period between receiving instructions and record firing. Effectiveness of performance would be determined by the number of hits scored on pop-up targets at 25 and 50 meters and the amount of ammunition expended in 20 exposures to the targets.

Figure 2. Weapons assembly/disassembly with LADs.

Table 1

OBJECTIVES OF FORT JACKSON FIELD TEST

1. Determine if basic rifle marksmanship Night Fire requirements can be conducted during daylight using LADs while satisfying current Night Fire training and performance requirements.

2. Determine the optical density of the LAD lens which best simulates the visual conditions appropriate for night firing.

3. Determine if the LADs can be used in varying weather conditions while maintaining the individual's capability to detect and engage targets.

4. Determine if the LADs can be worn over an individual's corrective lenses (eye glasses) while maintaining Night Fire training and hit probabilities.

POTENTIAL APPLICATIONS OF LADS

The LADs program at ARI encompasses a variety of light-attenuation devices and is not restricted solely to the fabrication of goggles for night rifle marksmanship training. Rather, it is envisioned that the program will continue in its attempt to meet the numerous training, testing, and proficiency maintenance needs of the Army. There are a great many potential military applications for LADs. Consider for a moment the feasibility of incorporating such devices into small unit tactical maneuvers and exercises, land navigation tasks, vehicle (track and wheel) driver training, and crew-served and individual weapon firing. The idea of conducting night training during daylight by equipping all participants with LADs does not seem as far-fetched now as it did when it was first proposed several years ago.

It is important to note that the LADs cannot provide an exact replication of night visibility conditions. No technological device can accomplish this. Rather, the LADs serve to approximate, albeit to a less than perfect degree, the essential features of such conditions. Because of this limitation, inherent in all simulations, LADS cannot be applied directly in certain areas of training. For example, since the LAD filters attenuate light by several orders of magnitude, small amounts of focused or diffused light (such as that emitted by the luminous dial of a compass or the instrumentation panel of a vehicle) cannot be seen with the LADS. Consequently, the LADs may not be useful

Figure 3. Serving chow with LADs.

for training in tasks typically performed at night with limited levels of artificial illumination. These limitations can be circumvented in many training situations, however, by making either procedural changes (such as increasing the intensity of the light source) or technological modifications to the LADS (such as using bidensity filters with less attenuation in certain parts of the lenses).

The potential military applications of devices which simulate night visual conditions for training purposes are much broader than the rifle marksmanship example. In particular, the increased range, lethality, and accuracy of modern weapon systems have led to evolving tactics and doctrine which emphasize the concept of continuous operations. This concept specifies that combat and support operations be conducted around the clock, under all illumination levels, and across varying terrains. The conduct of missions at night or under limited visibility conditions (e.g., during smoke screen) is intended to reduce the effectiveness of modern weapons in the hands of the enemy. Accordingly, to conduct successful continuous operations, combat and support personnel must be trained to perform their tasks with reduced visual cues. The potential role of LADs in developing continuous operations capability cannot be overemphasized (Figures 3 & 4).

Figure 4. Machine gunfire with LADs.